

WHAT IS CLAIMED IS:

1. A photocathode for emitting electrons in response to incident light, comprising:

5 a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

 a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

10 a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

 a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

15 a surface electrode provided on said third semiconductor layer;

 an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

20 a backside electrode provided on the second surface of said semiconductor substrate,

 wherein a minimum interval $2L$ between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of the second semiconductor layer, is $0.2 \mu\text{m}$ or more but $2 \mu\text{m}$ or less.

2. A photocathode for emitting electrons in response to incident light, comprising:

5 a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

 a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

10 a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

 a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

15 a surface electrode provided on said third semiconductor layer;

 an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

20 a backside electrode provided on the second surface of said semiconductor substrate,

 wherein the value V of the voltage applied between said surface electrode and said backside electrode divided by a minimum interval $2L$ between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor

layer, is 2 (V/ μ m) or more.

3. A photocathode for emitting electrons in response to incident light, comprising:

a semiconductor substrate of a first conductive type,
5 said semiconductor substrate having a first surface and a second surface opposing the first surface;

a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

10 a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the
15 surface of said second semiconductor layer is exposed;

a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said
20 second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

a backside electrode provided on the second surface of said semiconductor substrate,

wherein, when a thickness of said second semiconductor layer is D (m), a minimum interval between parts of said
25 third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second

semiconductor layer, is $2L$ (m), a carrier density of said second semiconductor layer is N (m^{-3}), and the voltage applied between said surface electrode and said backside electrode is V (V), said photocathode satisfies the following relationship:

$$D^2 + L^2 \leq 3.0(1+V) \times 10^9/N.$$

4. A photocathode for emitting electrons in response to incident light, comprising:

a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

a backside electrode provided on the second surface

of said semiconductor substrate,

wherein, when a thickness of said second semiconductor layer is D (m), a minimum interval between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor layer, is 2L (m), and the voltage applied between said surface electrode and said backside electrode is V (V), said photocathode satisfies the following relationship:

10 $D^2 + L^2 \leq 6.0(1+V) \times 10^{-13}$.

5. A photocathode for emitting electrons in response to incident light, comprising:

a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

15 a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

20 a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

 a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

25 a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and
5 a backside electrode provided on the second surface of said semiconductor substrate,

wherein, when a minimum interval between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor layer, is $2L$ (m), a carrier density of said second semiconductor layer is N (m^3), and the voltage applied between said surface electrode and said backside electrode is V (V), said photocathode satisfies the following relationship:

$$L^2 \leq 3.0(1+V) \times 10^9/N.$$

15 6. A photocathode for emitting electrons in response to incident light, comprising:

a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

20 a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

25 a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third

semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

a surface electrode provided on said third semiconductor layer;

5 an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

a backside electrode provided on the second surface of said semiconductor substrate,

10 wherein, when a minimum interval between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor layer, is $2L$ (m), and the voltage applied between said surface electrode and said backside electrode is V (V), said photocathode satisfies the following relationship:

$$L^2 \leq 6.0(1+V) \times 10^{-13}.$$

7. A photocathode for emitting electrons in response to incident light, comprising:

20 a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

25 a second semiconductor layer of the first conductive

type provided on said first semiconductor layer;

a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the 5 surface of said second semiconductor layer is exposed;

a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part 10 in the surface of said second semiconductor layer; and

a backside electrode provided on the second surface of said semiconductor substrate,

wherein, when a thickness of said second semiconductor layer is D (m), a minimum interval between parts of said 15 third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor layer, is 2L (m), and a carrier density of said second semiconductor layer is N (m^3), said photocathode satisfies the following relationship:

20 $D^2 + L^2 \leq 3.3 \times 10^{10} / N.$

8. A photocathode for emitting electrons in response to incident light, comprising:

a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a 25 second surface opposing the first surface;

a first semiconductor layer of the first conductive

type provided on the first surface of said semiconductor substrate;

a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

5 a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

10 a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

15 a backside electrode provided on the second surface of said semiconductor substrate,

wherein, when a thickness of said second semiconductor layer is D (m), and a minimum interval between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor layer, is 2L (m), said photocathode satisfies the following relationship:

$$D^2 + L^2 \leq 6.6 \times 10^{-12}.$$